[12604/18]

LATERAL GUIDANCE TRANSPORTATION SYSTEM

Background of the Invention

The present invention relates to a lateral-guidance transportation system.

The German Patent 197 35 624 C1 describes a method for the non-contact transmission of electric power from a medium-frequency current source having a medium frequency f_M to one or more moving consumers via a transfer line, and from the pick-ups, allocated to the moving consumers, having a downstream mobile converter for adjusting the power received from the transfer line, the transfer line being fed by the medium-frequency current source with a medium-frequency current that is constant in its effective value during the power transmission.

The mobile converter converts the medium-frequency current, injected from the pick-up, into a DC voltage. As described in Figures 3, 7a and 7b and the associated specification of DE 197 35 624 C1, switch T_S is operated synchronously with respect to the characteristic, and with double the frequency of the input current of the mobile converter. However, an important disadvantage is that this high switching frequency 2 f_M results in high switching losses. Another disadvantage is that the synchronous principle can no longer be maintained when using a plurality of asynchronously operating power supplies for supplying a mobile converter.

A method is known from DE 100 53 373 A1 which, by contrast to DE 197 35 624 C1 is operated asynchronously, and has lower switching losses.

A conveyor device is known from DE 33 42 184 A1 that includes guide rails and is curve-negotiating with positive steering.

DE 198 49 276 C2 describes a method for traveling along a line using a curve-negotiating storage and retrieval vehicle for a high-bay warehouse. Such systems are supplied using a contact wire that does not operate free from wear.

From web page http://www.sew-eurodrive.de/deutsch/03produkte/index produkte.htm high-bay warehouses and appertaining operating devices are known.

From the flyer of the firm SEW-EURODRIVE GmbH & Co. KG, "Product Announcement MOVITRANS" system components are known, the transmission head being designated as a pick-up, and being connected to a mobile converter, which makes available a supply voltage for a load.

From DE 196 26 966 A1 a transport system having satellite vehicles is known, in which the main vehicle is supplied with energy in a contactless manner. In addition, satellite vehicles are also supplied with energy in a contactless manner. It is a disadvantage, in this case, that a satellite vehicle has a great overall height because of the space requirement of the U-shaped pick-ups. In addition, both in the main aisle and in the side aisles or shelf areas, primary circuits, that is, for example, line conductors, are laid out, which have constantly to be provided with current. Consequently, radiation losses are great.

From the prospectus Planar E-Kerne for SMPS, that is, switching power parts, of the firm Kaschke KG from the year 2003, E-shaped planar cores are known.

Therefore, the present invention is based on the object of further developing a storage and retrieval warehouse and an appertaining storage and retrieval operating unit for a high-bay warehouse that may be executed in a cost-effective and a compact manner.

According to the present invention, the object is attained by the transportation system according to the features stated in Claim 1.

Important features of the present invention of the transportation system are that it is executed having at least one route made up of carrier and lateral guidance elements, on which at least one transportation vehicle is guided as the main vehicle, which has means for automatically moving away along the route, and to which energy is transmitted by a primary circuit having a contact wire laid out along the route, or in a contactless manner,

the main vehicle including a lifting platform that is able to be driven by a drive, especially, for example, an electric motor or a geared motor, and on which there is at least one satellite vehicle that is also includes a drive, such as, for example, an electric motor or a geared motor, for automatically moving away along an additional route, and which is developed for transporting goods,

the route including a satellite route section for the positioning and parking of the satellite vehicle,

the satellite route section being truly alignable, by positioning of the main vehicle along its route, on satellite routes situated transversely to the latter, these satellite routes being situated on shelves,

satellite route sections and satellite routes including primary conductors which are supplied with energy in a contactless manner from the main vehicle.

In this context, the advantage is that less cabling is required, the radiation is lowered, the expenditure of distribution boxes and appertaining electrical and electronic

components and costs are diminished. Besides that, the transportation system may be implemented in a compact manner.

In one advantageous embodiment, the drive of the lifting platform is supplied with energy in a contactless manner. In particular, the drive of the satellite vehicle is supplied with energy in a contactless manner. In this context, it is advantageous that the wear and the maintenance expenditure are lowered.

In one advantageous embodiment, energy is transferable at one place in a contactless manner by the main vehicle to at least one primary conductor of at least one shelf of at least one side aisle. In this context, it is of advantage that only that shelf, or those shelves, are supplied with current, in which the satellite vehicle is located. Other primary lines do not have to be supplied with current. Consequently, no electrical distribution devices are necessary. In addition, the radiation and the costs are able to be lowered.

In one advantageous embodiment, at least one pick-up is provided for the contactless energy transfer. In this context it is advantageous that it is implementable compactly and/or having a high efficiency.

In one advantageous embodiment, the main vehicle includes a power supply unit that feeds a primary line, provided on the main vehicle, which is inductively coupled to a pick-up which is connected to a terminal box for impedance compensation, and which feeds at least one primary line provided in the satellite route section. In this context it is of advantage that, depending on the application, the impedance is adjustable.

In one advantageous embodiment, the main vehicle includes a primary line which may, during the aligning, be inductively coupled to a pick-up, laid out in the floor, which is

connected, for impedance compensation, via a terminal box, to at least one primary line provided in a shelf. This is advantageous in that the position of the main vehicle controls the supplying of current to the primary conductors of the shelves. Consequently, no further distribution devices are necessary.

In one alternatively differently constructed, advantageous embodiment, the lifting platform includes a primary line, especially a pick-up provided as a primary line, which, when there is aligning orientation of the main vehicle and the vertical positioning of the lifting platform, is able to be inductively coupled to a pick-up, provided at the shelf, which is connected via a terminal box to at least one primary line provided in a shelf, for impedance compensation. In particular, the supplying with current of the primary conductor of the respective shelf takes place from the main vehicle. This is advantageous in that the positioning of the main vehicle and of the lifting platform controls the supplying of current to the primary conductor of the shelves.

In one advantageous embodiment, at least one pick-up is developed to have a U-shaped or a C-shaped or an E-shaped ferrite core. This offers the advantage that a high degree of efficiency is attainable.

In one advantageous embodiment, at least one pick-up includes a winding executed as a flat winding. In this context, the advantage is that a very compact development may be attained for the shelf warehouse including main vehicle and satellite vehicle.

In another advantageous embodiment, the flat winding is positioned around the middle leg of an E-shaped core. The advantage here is that, in spite of the flat winding, high efficiency is attainable in the contactless energy transmission.

In yet another advantageous embodiment, the legs of the E are shorter than the distance of the next nearest legs from one another. This has the advantage that the embodiment is very compact.

In one advantageous embodiment, the primary line is executed as an outgoing line and a return line, or as an outgoing line and an at least partially surrounding profile. In this context it is of advantage that, depending on the application, the system of contactless energy transmission is adjustable.

Further advantages are yielded from the dependent claims.

List of Reference Numerals

1	line conductor for side aisle
2	pick-up, flat
3	pick-up, U-shaped
4	power supply unit
5	terminal box
6	vehicle control
7	pick-up, flat
8	main vehicle
9	satellite vehicle
10	main vehicle line conductor, vertical
11	terminal box
12	line conductor, lifting platform
13	line conductor horizontally laid out on the vehicle floor in the main vehicle
14	pick-up, flat
15	pick-up, flat
16	capacitor for compensation
17	matching transformer
18	capacitor for compensation of the line
51	aluminum plate
52	flat winding
53	molding compound
54	planar core

The present invention will now be explained in greater detail with reference to the figures:

The present invention includes systems for contactless energy transmission, as shown in the related art. In particular, in this context, a pick-up is provided on the movable part, which includes at least one winding. The non-movable part of the system includes, as the primary line, at least one line conductor and one return line. The return line may be implemented either in a profile or as a line conductor. The pick-up is inductively coupled to the line conductor(s). If the return line is carried out as a profile, the pick-up is designed in such a way that at least its ferrite core surrounds the line-type outgoing line at least partly. Accordingly, the pick-up is designed U-shaped or C-shaped. The secondary winding, that is, the winding of the pick-up, is carried out around the legs of the U or C. If the return line is executed as a line conductor, the ferrite core is advantageously executed as an E-shaped core, the two lines, that is, the outgoing line and the return line, being situated between the legs of the E, in the leg direction, at a slight distance from this position.

A shelf warehouse of the present invention and a shelf operating unit are shown in Figure 1.

The shelf operating unit includes a main vehicle 8, on which a satellite vehicle 9 is provided, which is movable by a lifting platform, that is vertically movable by a drive, to a shelf of the shelf warehouse. The shelf warehouse has two shelves in Figure 1.

The shelves are situated one over the other in a side aisle. Additional side aisles are sketched symbolically in Figure 2. Figure 2 also shows as primary line line conductor 1 laid out in a shelf, having an outgoing and a return line, this primary line being electrically connected to a terminal box 5, which

in turn is connected to a flat pick-up 7 that is rigidly positioned in the floor. Terminal box 5 includes an electronics system for impedance matching, which is shown in exemplary fashion in Figure 3, in additional exemplary embodiments similarly constructed circuits, which at least include the functions of Figure 3, being also foreseeable.

As shown in Figure 1, on the lifting platform a line conductor is provided which, after reaching the correct height of the shelf of the shelf warehouse, is situated in such a way that line conductor 1 located in the side aisle is in alignment with the line conductor of the lifting platform. Consequently, it is made possible for the satellite vehicle to be supplied with energy in contactless fashion, especially during travel of the lifting platform into the shelf and back.

In order to take on energy, satellite vehicle 9 includes a flat pick-up 2. In addition, satellite vehicle 9 includes a vehicle control, which is supplied from pick-up 2 and an electronic circuit that is not shown, and that is electrically connected with it, that is also designated as mobile converter. In additional exemplary embodiments according to the present invention, these components are also able to be developed in integrated fashion, and thus take up less space. In particular, a housing is providable for the integrated design, and thus the mass may be reduced, which contributes to the dynamic behavior of the vehicle.

The lifting platform is vertically movable and includes a drive for this, which is supplied in contactless fashion from the primary line of the main vehicle. For this, at the lifting platform, a U-shaped pick-up 3 is provided and as primary line, a line conductor 10 is provided at the main vehicle. Consequently, there is a high efficiency in the energy transmission. The space requirement for the U-shaped pick-up does not interfere, since the contactless energy

supply is situated at the side of the main vehicle, that is, in the direction of motion.

The drive of the main vehicle and at least one power supply unit 4 are electrically supplied using contact wires that are not shown. Power supply unit 4 supplies vertical line conductor 10 and an additional line conductor 13, which is laid out horizontally on the vehicle floor of the main vehicle. This additional line conductor 13 is also supplied by power supply unit 4, and is situated so that, during positioning of line conductor 12 of the main vehicle in alignment with line conductor 1 of the side aisle, line conductor 13 is positioned over a flat pick-up 7, that is laid out in the floor. Thus, energy is transferable to this flat pick-up 7 by line conductor 13. Flat pick-up 7 is connected electrically to terminal box 5, which is provided for distributing to line conductors 1 of the shelves.

The satellite vehicle, in turn, includes at least one flat pick-up 7, for taking on energy, which is coupled to the line conductor of the lifting platform or the shelf. Since the power supply unit supplies both line conductors either directly or indirectly, no substantial fluctuation in the energy supply is noticeable when the satellite vehicle travels out of the lifting platform.

In further exemplary embodiments according to the present invention, satellite vehicle 9 includes several flat pick-ups for picking up energy. Consequently, depending on requirement, more energy is transferable to the movable vehicle part.

Figure 4 shows another exemplary embodiment according to the present invention, in which a flat pick-up 15 is affixed to the lifting platform, which, upon in-alignment positioning of line conductor 12 of the route of the satellite vehicle of the lifting platform and of line conductor 1 of the shelf, is also

positioned aligned in front of a flat pick-up 14 that is firmly connected to the shelf, which is in electrical contact with line conductor 1 of the shelf and supplies it. Consequently, only respectively required line conductor 1 of the respective shelf is supplied with current, and as little energy as possible is lost.

The lifting platform includes terminal box 11, which is electrically connected to U-shaped pick-up 3, and supplies line conductor 12 of the lifting platform. In the exemplary embodiment according to Figure 4, terminal box 11 also supplies flat pick-up 15, that is affixed to the lifting platform, and that supplies the respective flat pick-up 14 in the in-alignment positioning.

Figure 3 shows the circuit diagram of terminal box 5. In this context, secondary winding 7 of flat pick-up 7 of Figure 1, that is laid out in the floor, is connected via a capacitor 16 to the primary winding of matching transformer 17 for the compensation of pick-up inductance 7. The latter's secondary winding is connected via a capacitor 18, for the compensation of the route, that is, of line conductor 1, in series with line conductor 1 as primary conductor. Consequently, the impedances may be optimized using capacitors 16 and 18, and using matching transformer 17.

In additional exemplary embodiments according to the present invention, instead of the supply of the main vehicle using a contact wire, supply using a system of contactless energy transmission is conceivable. Thus, wear and maintenance costs are advantageously able to be further reduced.

In further exemplary embodiments of the present invention, instead of two shelves, a plurality is foreseeable, and instead of one lifting platform, a plurality, and instead of one satellite vehicle, a plurality of these too.

In additional exemplary embodiments according to the present invention, instead of flat pick-ups, U-shaped and C-shaped pick-ups may also be used.

The present invention not only relates to shelf operating units but also to other lateral-guidance transportation systems having at least one route made up of carrier elements and lateral-guidance elements on which at least one transportation vehicle is guided as the main vehicle that has means for automatic movement along the route, and to which energy is transferred in a contactless manner from a primary circuit laid down along the route, the main vehicle including a lifting platform which is able to be driven by a drive, such as an electric motor or a geared motor, and on which there is located at least one satellite vehicle, which also includes a drive, such as an electric motor or a geared motor for the automatic movement along an additional route, and is developed for the transportation of goods. In this context, the route of the satellite vehicle is formed of a first part, that belongs to the lifting platform, and may be designated as a satellite route section, and at least one further part that belongs to a shelf or the like, and is designated as a satellite route. In this context, in the route of the satellite vehicle, on the one hand, that is, in the part located on the lifting platform, and on the other hand, in the part located on the shelf, a primary conductor, such as a line conductor or a primary winding is provided.

The satellite vehicle includes a pick-up that is coupled to the primary conductor, and consequently makes possible a contactless energy transmission. Likewise, the lifting platform includes a pick-up that is inductively coupled to a primary conductor, such as a line conductor or a primary winding, and consequently the lifting platform is also able to be supplied with energy in a contactless manner. The pick-up may be developed either U-shaped or, advantageously, flat. In the flat embodiment, the pick-up includes a flat winding that

is positioned around the middle leg of an E-shaped core. The legs of the E, in this context, may be made short, because the flat winding has only a small height in the direction of the leg of the E. In this context, the primary line is executed as an outgoing line and a return line. In comparison to a U.

In the present invention it is also essential that the supply of current to the primary line of the respective shelf takes place from the main vehicle, and therefore wiring expenditure is able to be saved. Besides, no costly energy distribution needs to be provided, using distributors or even controllable distribution boxes. In a shelf warehouse having many shelves, therefore, the savings in expenditures and costs are very great.

The primary line is developed as a long extended conductor device. Power supply unit 4 is designed as a medium frequency source for supplying the connected primary lines.

Figure 5 shows symbolically an exemplary flat pick-up 2, 7, 14 in cross section. An E-shaped planar core 54 is wound with a single layer flat winding 52, which is encapsulated in an encapsulation compound 53. The E-shaped planar core is partially surrounded by an aluminum plate 51. In further exemplary embodiments according to the present invention, instead of single layer flat windings, multilayer ones may also be provided.

In other exemplary embodiments according to the present invention, similarly acting pick-ups may also be used, which are not designed exactly the same, but similarly.